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have dissolved the simple idea of an extended body, say of a chair, which a child understands, into a bewildering notion of a complex dance of molecules and atoms and electrons and waves of light. They have thereby gained notions with simpler logical relations.

Space as thus conceived is the exact formulation of the properties of the apparent space of the common-sense world of experience. It is not necessarily the best mode of conceiving the space of the physicist. The one essential requisite is that the correspondence between the common-sense world in its space and the physicists' world in its space should be definite and reciprocal.

I will now break off the exposition of the function of logic in connection with the science of natural phenomena. I have endeavored to exhibit it as the organizing principle, analyzing the derivation of the concepts from the immediate phenomena, examining the structure of the general propositions which are the assumed laws of nature, establishing their relations to each other in respect to reciprocal implications, deducing the phenomena we may expect under given circumstances.

Logic, properly used, does not shackle thought. It gives freedom and, above all, boldness. Illogical thought hesitates to draw conclusions, because it never knows either what it means, or what it assumes, or how far it trusts its own assumptions, or what will be the effect of any modification of assumptions. Also the mind untrained in that part of constructive logic which is relevant to the subject in hand will be ignorant of the sort of conclusions which follow from various sorts of assumptions, and will be correspondingly dull in divining the inductive laws. The fundamental training in this relevant logic is, undoubtedly, to ponder with an active mind over the known facts of the case, directly

observed. But where elaborate deductions are possible, this mental activity requires for its full exercise the direct study of the abstract logical relations. This is applied mathematics.

Neither logic without observation, nor observation without logic, can move one step in the formation of science. We may conceive humanity as engaged in an internecine conflict between youth and age. Youth is not defined by years, but by the creative impulse to make something. The aged are those who, before all things, desire not to make a mistake. Logic is the olive branch from the old to the young, the wand which in the hands of youth has the magic property of creating science.

A. N. WHITEHEAD

#### DR. HALDANE'S SILLIMAN LECTURES

DR. J. S. HALDANE, of the University of Oxford, gives the Silliman lectures at Yale University on October 9, 10, 12 and 13. The general subject of the lectures is: Organization and Environment as illustrated by the Physiology of Breathing. The topics of the separate lectures are:

*Lecture I.*—The problem presented by the co-ordinated maintenance of reactions between organism and environment—vitalistic and mechanistic attempts at explanation; The elementary facts relating to breathing; The respiratory center and the blood; Alveolar air and the exact regulation of its CO<sub>2</sub> percentage; Apnea and hyperpnea; Varying frequency of breathing; Physiological effects of varying pressures of gases; Effects of deprivation of CO<sub>2</sub>; Effects of air of confined spaces and mines; Effects of compressed air in diving; Influence of the vagus nerves in breathing; Coordination of the responses to central and peripheral nervous stimuli, so that the respiratory apparatus acts as a whole.

*Lecture II.*—The gases of the blood; Oxyhemoglobin and the conditions of its dissociation; The combinations of CO<sub>2</sub> in the blood and their dissociation; Effects of oxygenation of hemoglobin on the dissociation of CO<sub>2</sub>; Exact physiological regulation of the blood-gases; Evidence that CO<sub>2</sub> acts physiologically as an acid; Investigations of

the reaction of blood; Extreme delicacy of the physiological regulation of the blood reaction; Regulation by the lungs, liver and kidneys; Effects of want of oxygen on the breathing; High balloon ascents, CO poisoning, and mountain sickness; Acclimatization to oxygen want:—the Anglo-American expedition to Pikes Peak in 1911; Acclimatization effects of oxygen want on the breathing; Acclimatization effects on the hemoglobin percentage and blood-volume; Acclimatization effects on active secretion inwards of oxygen by the lungs; Factors in acclimatization to want of oxygen.

*Lecture III.*—Further analysis of oxygen secretion by the lungs; Secretion of oxygen by the swim-bladder; Secretion in other glands; Analogy between secretion and cell-nutrition; The circulatory regulation of carriage of oxygen and CO<sub>2</sub>; Regulation by vaso-motor nervous control; Evidence that this control depends upon the metabolism of the tissues; Evidence that the heart's action in pumping blood depends on the same conditions; Part played by contraction of the veins; The blood as a constant internal environment; Regulation of this internal environment by the kidneys; Regulation by other organs; Regulation after bleeding and transfusion; Regulation of the external environment; In reality the constancy of the internal or external environment is a balance between disturbing and restoring influences, each of which persists; The ordinary idea of "function" in an organ is misleading; "Causes" and "stimuli"—physiology as an endless maze of causes.

*Lecture IV.*—Examination of mechanistic interpretation of regulation of the environment; Difference between an organism and a machine; Life endures actively and develops; In life the whole is in the parts and the past is in the present; Organism, environment and life-history can not be separated; For biology life and not matter is the primary reality; The true aims and methods of biology; Biology an exact experimental science; Relation of physiological to physical and chemical investigation of organisms; The limitations of existing physical and chemical conceptions; Inadequacy of vitalism; Vitalism the inevitable accompaniment of attempted mechanistic interpretations of life; Individual life as a part of a wider life; The limitations of biological conceptions; Science and religion.

#### SCIENTIFIC NOTES AND NEWS

JOSIAH ROYCE, Alvord professor of the history of philosophy at Harvard University, dis-

tinguished for his contributions to philosophy, logic, ethics and psychology, died on September 14, in his sixtieth year.

THE British government has appointed two committees to inquire, respectively, into the position of science and modern languages in the system of education of Great Britain. The members of the committee on science are: Sir J. J. Thomson (chairman), the Rt. Hon. F. D. Acland, Professor H. B. Baker, Mr. Graham Balfour, Sir William Beardmore, Bart., Sir G. H. Cloughton, Bart., Mr. C. W. Crook, Miss E. R. Gwatkin, Sir Henry Hibbert, M.P., Mr. William Neagle, Mr. F. G. Ogilvie, C.B., Dr. Michael Sadler, C.B., Professor E. H. Starling, Mr. W. W. Vaughan, Mr. F. B. Stead, inspector of schools, secretary. This committee is instructed "to inquire into the position occupied by natural science in the educational system of Great Britain, especially in secondary schools and universities; and to advise what measures are needed to promote its study, regard being had to the requirements of a liberal education, to the advancement of pure science, and to the interests of the trades, industries and professions which particularly depend upon applied sciences."

SIR CHARLES H. BEDFORD has been appointed general secretary of the newly constituted Association of British Chemical Manufacturers. The business of the association is for the present being carried on at the offices of the Society of Chemical Industry.

DR. I. J. KLIGLER, who has been in immediate charge of the bacterial collection of the department of public health of the American Museum of Natural History, has resigned to accept a position with the Rockefeller Institute. His place will be taken by Thomas G. Hull, Ph.D. (Yale, '16).

THE Boston City Council has passed an ordinance that will give the city police court a medical department and psychologic laboratory. All offenders will pass through this department, the verdict of which as to their mental condition will be taken into consideration before sentence is pronounced. Dr. Victor V. Anderson is appointed as head.